ON THE APPARENT STRUCTURE OF THE SCALES OF SEIRA BUSKII IN RELATION TO THE SCALES OF LEPIDOCYRTUS CURVICOLLIS.

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The structure of the scale of *Lepidocyrtus curvicollis* has occupied the attention of microscopists from the time it was adopted by opticians in England, and I believe also in America, as a test object whereby to ascertain the correction of their objectives, and yet the question may be asked, though so often examined, has its structure been satisfactorily established or accepted ? Would not the general answer be a negative one ? It is feared it would. Now, I am not bold enough to do more than to put in a plea for the careful examination of the scale of *Seira buskii*, which is more robust, in the hope it may help in the elucidation of the finer marked scale of *Curvicollis*.

It may be remarked that both scales are derived from the Poduridæ, and as they both present the markings termed "notes of exclamation," may we not reasonably consider that both are constructed upon the same plan, differing only in minuteness of detail ? I have been led to this subject by finding some appearances in the scales of *Buskii*, which seemed to me to offer a chance of getting a little insight into the real structure of both scales ; but I at once readily confess still to a difficulty in formulating a theory or statement not open to question. It is, therefore, under this difficulty the subject is approached and the following remarks offered for the consideration of the members of your society. There is, however, one point on which I have less hesitation, viz., that the appearances the scale of *Seira* have presented, prevent participating in the supposition that the notes in either are due to minute spinous projections on either the upper or under surface of the scale, or that they are anything more than optically due to refraction through adherent and separated portions of the membranes forming the surfaces and the inner framework of the scale, surrounded by a more highly refracting substance.

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* Elected an honorary member of the American Microscopical Society, August 20, 1896.

As the appearances in *Curvicollis* are so well known, let me turn at once to the scales of *Buskii*, where the notes are so much larger. On taking a general view of these scales, we find they differ very much in size and in the robustness of the notes on the scale. The small scales often have the notes stronger and thicker, or wider than in the large scales, and in some the center ones run without a break from the stem to nearly the point. This is shown in the Photograph No. 1, × 710 diameters ; moreover, these small scales often scarcely show any light areas in the note of exclamation, consequently it seems to present a more or less solid structure. While the larger scales have these notes many times more numerous than the smaller scales, and almost all of them under high powers show long open or light central areas, as in Photograph No. 2, × 930 diameters. Looking on these as types of the perfect scale, we meet with others which show that there is between these notes throughout the scale a more highly refracting substance, which does not in *Buskii* appear to be of such a fatty nature as in *Curvicollis*. This substance in many of the scales on the slide, which is an old one, has receded in continuity from the stem toward the point, appearing abruptly broken across in the interspaces between the notes, yet at the same time leaving the lower point or tail of the note a mere line ridge, or bar starting from the base or stem end of the scale. This is seen in Photograph No. 3, × 710 diameters. A step further, and this material is found in a granular condition, occupying the interspaces between the lower notes while the notes remain nearly perfect toward the point of the scale. See Photograph No. 4,

× 1000, and Photograph No. 3, × 710, where the process is fainter. One step more, and now this substance is seen dispersed throughout the scale in one uniform mass, save at minute points on the edges, and only darkish lines, bars or spaces are seen more or less extending from the stem to the point. Here we may say we have entire obliteration of the notes. What has become of the notes? They have vanished, leaving only shaded areas in their place. This appearance is shown in Photograph No. 5, × 1000 diameters. It was then finding these scales that led me to hope some clue could be gathered as to the cause of the notes of exclamation, and induced me to puzzle over what might be the entire structure of the scale. For comparison I had by me the large engraved plate of the scale of *Lepisma sacharina* with copious marginal notes, given me November, 1863, by the distinguished microscopist and draughtsman, the late Richard Beck. Mr. Beck found in his scale two sets of bars or lines which intersecting each other at different angles thus produced either vertical or oblique notes "by the refraction of light, when the structure of the outer and inner surfaces of the scale cross each other in different directions." And he states "that when moisture is on the outer surface, the radiating or the oblique lines become continuous, but when the moisture is on the inner surface, then the longitudinal markings are continuous, and when no fluid is present, both sets of markings are interrupted." According to this view, the obliteration of the notes is the effect of moisture. Now, in the scales of *Buskii*, it seemed to me, the obliteration of the notes is due to the refraction, breaking up or universal spreading of the inclosed more highly refracting substance; in other words, that it is broken down and no longer lies only in the interspaces between the notes. At the edges right and left of the base of some of the scales, we have more or less indications of the oblique lines found in *Lepisma*, but I have failed to trace them, and if they exist beyond or towards the stem or the central part of the scale, I consider they do not from their direction any way share in the cause of the long or longitudinal notes in *Buskii*. How then can the appearance of these notes be explained? May we not suppose that the structure of the entire scale consists of a very delicate oblong bag, more or less conversely curved on its outer surface, and more or less flat or concave on its inner surface, or in cross section somewhat plano-convex or convexo-concave, and that these delicate membranes are supported or strengthened by an inner framework of longitudinal bars, extending from the base and gradually approaching the center, until they nearly or quite meet at the tip of the scale, all but the most central ones taking a slight curve right and left at the base, and following the shape of the scale. The membranes of the bag I regard as plain, though some may possess a few lines or bars radiating from the stem each side, which I regard as due to curved notes embracing the lower rounded or more inflated edges of the scale. This small sac seems filled with a semi-solid or thick fluid substance of a rather higher refracting power than either the membrane or framework. In addition, if we suppose that the two membranes, *i. e.*, the upper and under, adhere in part to the longitudinal bars of the supporting inner frame in their course to the point of the scale, and break away from the bars at various points to again unite either to the same bar or its neighbor, repeating the process of adherence or close approximation and separation all over the scale, should we not have the bright areas; and if the bars were themselves at all concave and the membranes touched the edges, but not the center for the whole length of the note, should we not have the appearance of the open areas, the head of the note being closed in by the capillarity of the semi-fluid interspace substance? This would tend to give the bars a more or less double outline, as in the Photograph No. 6, × 930 diameters. This may appear as only a fanciful rendering of the structure, but had I to try and fabricate a monster scale with any transparent plastic substance, it would be the first method adopted. The point or dark tail of the note would have the bar and membranes closely adherent, the clear areas the membranes only adherent to the edges of the bar, and then interrupted to repeat this arrangement. It may be noted that where the scale commences to have the notes changed into the appearance of only longitudinal lines or bars, the change always begins, as far as I can find, at the stem end of the scale, though the breaking up of the inner substance into a granular state may be only scantily apparent, and this change is regarded as sufficient to disturb the adherence of the membranes along the bars, working the same change gradually toward the apex, as seen in Photograph No. 4, × 1000 diameters. If complete, then the appearance shown in Photograph No. 5, at the same magnification, though the framework is only faintly indicated, possibly due to the inner substance having lost its original character and refractive quality. It may be said there is no true framework, and the bars are formed by folds or creases in the upper or under membranes; but in my examination and dissection, years since, extending over a long period, I was able to find an inner framework in the butterfly scale, and this tempts me to the idea of an inner support in the scale of *Buskii.*

To repeat, the dark line in the tail of the note is suggested as caused by the close adherence there of the three parts, upper and under membrane with that part of the frame and as it exists for a variable distance, so the tail of the note may be of variable lengths. The open or central light area is regarded as one of the two membranes adhering only at the edges, right and left of that bar, the interspaced material being drawn by capillarity close to the edges, thus assisting in forming the somewhat sharp outline at that part, and this process to continue through the length of the bar to the point of the scale, or to occur in the neighboring bars irregularly in *Buskii*, but more regularly in *Curvicollis*, where the interspace material is more or less fluid, and of a more refractive nature. The photograph of the Podura scale *Curvicollis*, is given just to show that in certain positions in relation to the illuminating rays, the indication of lines becomes apparent, and these are often lost in injury to the scale by reason of its delicacy and the highly refracting quality of the interspace material.

It must be distinctly understood that the above remarks are not put forward in any dogmatic spirit, but in the hope that in directing attention to the scale of *Buskii*, clearer views may be formulated, both of its structure and that of *Curvicollis*. At any rate it is trusted that the subject may prove of some interest to the members of your Society, and the readers of your TRANSACTIONS which abounds in interesting details connected with microscopy.

No. 1. A small perfect scale, × 710 diameters.

No. 2. The same large scale as No. 7, showing the notes, × 930 diameters.

No. 3. A medium scale, showing the bars at the base, the interspace material receding and granulation begun, × 710 diameters.

No. 4. A medium scale, with the granulation further advanced towards the apex, × 1000 diameters.

No 5. A medium scale, with the change completed and the notes lost, leaving only faint indications of previous existence, × 1000 diameters.

No. 6. The same large scale as Nos. 2 and 7, focused into showing a double line appearance, × 930 diameters.

No 7. A large perfect scale, × 668 diameters.

No. 8. A *Curvicollis* scale, showing a sort of lined appearance, especially on the right hand, and by way of comparison.